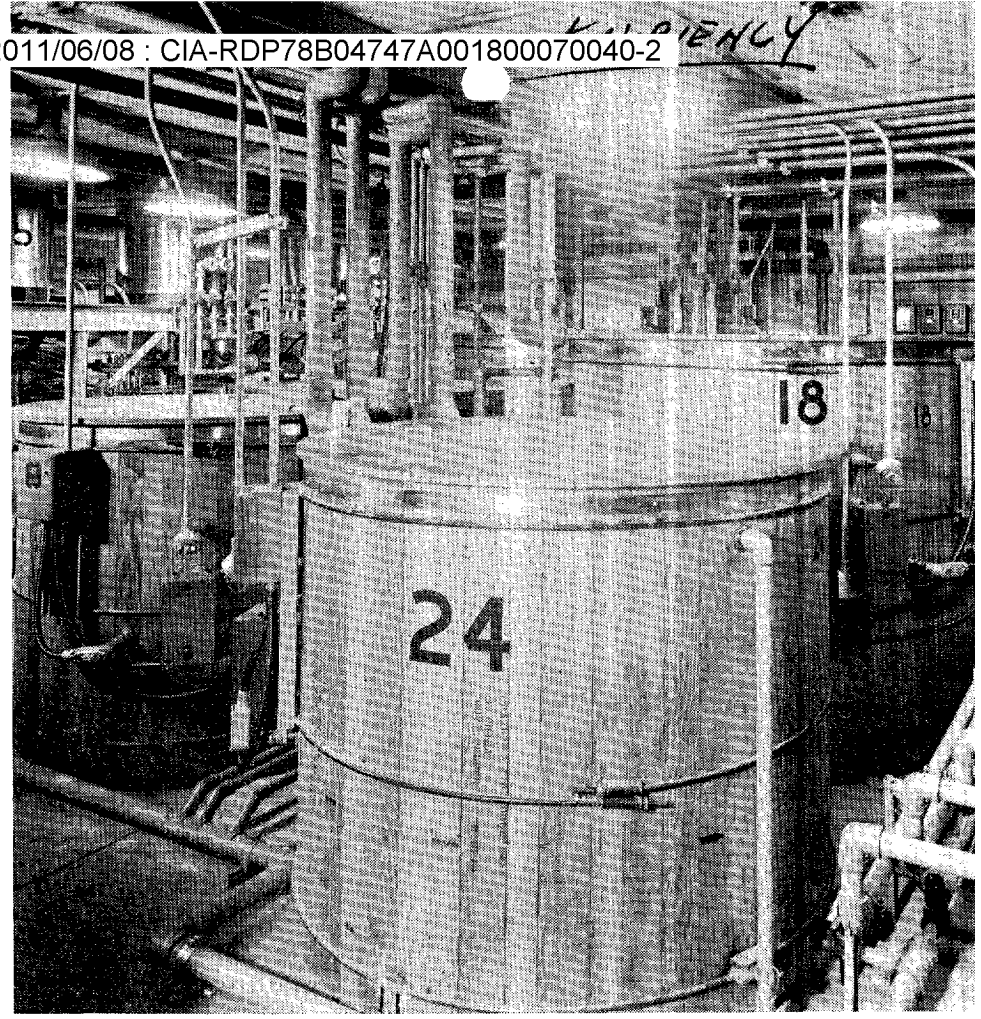
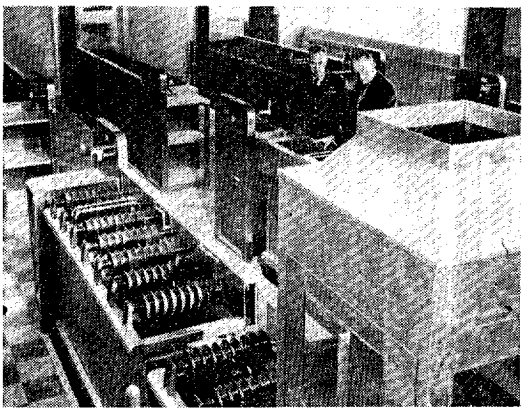
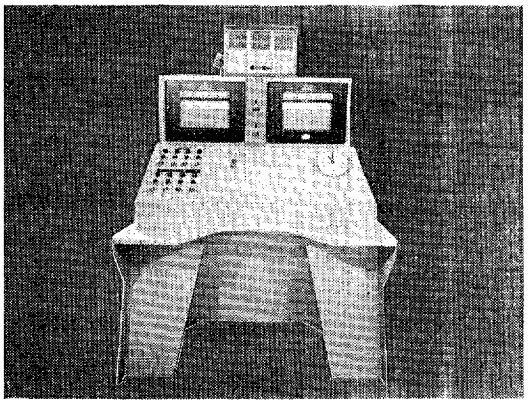


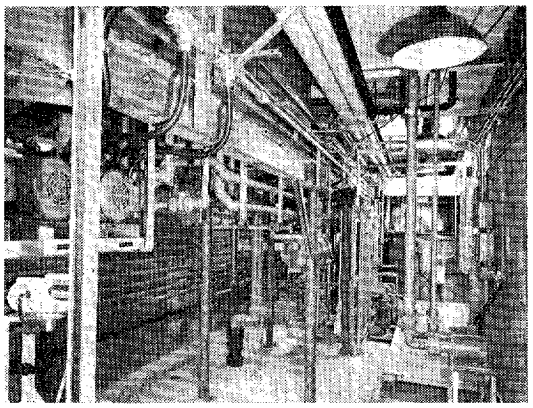
RIGHT: You're not looking at the innards of a brewery, but rather the heart of Cape Canaveral's center for color motion picture processing.



OVERALL VIEW of Houston-Fearless motion picture processing machines



PROCESSING chemical control console.



THIS NETWORK of chemical piping is part of the color bleach reversal system at the new photo lab. At the left is one of several safety fountains for quick wash if personnel become contaminated.

TOMORROW'S LAB TODAY

It seems only proper that Cape Canaveral, America's kickoff point to the future, should be serviced by one of the world's most advanced motion picture labs.

by JAMES HUGHES
Executive Editor

In this age of supersonic long-range missiles, documentary movies have become important tools for U. S. Air Force Air Research and Development Command scientists.

As permanent records of major missile firings, they are used by scientists to evaluate the results of tests and to compare them with the results of previous firings. When a missile misfires, films frequently enable scientists to pinpoint the area or sequence of error.

In keeping with the importance of photography to its mission, the Air Force Missile Test Center, Patrick Air Force Base, Cape Canaveral, Florida, recently began processing film in one of the largest and most versatile film processing laboratories in the world. The $1.4-million facility can process black-and-white and color film — 16, 35 and 70mm.

Eleven processing machines,

Q. How do color films compare with black and white in regard to graininess?

On this question the experiences of the panelists have led to considerable diversity of opinion.

Purrington states, "No color material permits print enlargement without appreciable grain [as compared] to the degree [of enlargement] possible [when] working with fine grain black-and-white materials."

Smolka notes, "We have encountered no grain problems whatsoever with negative films. However, we have encountered, on occasions, quite a bit of graininess in certain 35mm direct positive color films!"

Flanagan considers Kodachrome to be practically grainless but has observed that graininess in color films increases with their speed.

Livingood answers "Most color films show more apparent grain than black-and-white films," but he does not consider the graininess of color films a problem, since other qualities of a color image outweigh the grain disadvantage.

Morris expresses the view that unless a photographer was a "miniature" advocate (35mm or 2½ x 2¼ inches) color film graininess was of concern only to firms making murals.

Q. What light source should be used for viewing color prints or transparencies?

Livingood recommends a 4000K light source for a transilluminator, and suggests that it be placed in a semi-darkened room. When comparing a transparency with a color print made from it both should be viewed by the same source of illumination.

Purrington states that when working with art directors and engravers one should make sure that the same standard-type illuminator is used by everyone concerned.

Smolka says "I have heard so many conflicting discussions about the most suitable light source for viewing color prints and transparencies that I now just follow whatever the manufacturers recommend."

Q. Are color prints made directly from color negatives suitable as dye transfer prints for use in a) display b) reproduction?

The answers to this question attest to the fact that in color work the experts often do not share the same opinions.

For example, *Flanagan* replied, "Top quality Ektacolor prints are as suitable for display as dye transfers. For reproduction, dye transfer prints are more easily controlled and corrected. The quality is also better." *Meisel* took a different stand in stating, "Ektacolor prints will serve as well for display or reproduction as Dye Transfers. However, notwithstanding contrary assertions by the manufacturers, we feel that a Dye Transfer has a greater life expectancy than an Ektacolor print."

Stanton expresses the strictly personal view that color prints made directly from color negatives are preferable for display because costs can be kept within a tight budget but notes, "For reproduction it has yet to be proved to me that you can get as good printing plates from negative color prints as you can from dye transfer prints. It should be pretty obvious that you have all the control in the world with dye transfer, whereas I feel limitations do sneak into the control of negative color prints."

Purrington voices an "it all depends" approach. "For display purposes, prints from color negatives are entirely adequate. For reproduction, some are and some are not. The question can best be resolved by discussing it with the engraver who must reproduce from the print."

Smolka has complete faith in color transparencies for reproduction purposes. "We prefer to make direct positive transparencies for reproduction purposes because of the quality differential. For some reason or other, engravers and printers are able to get more sparkle from the transparency rather than the print. We know, however, that good reproduction from Ektacolor prints is available, but where our own pictures are concerned, we prefer the reproductions from transparencies."

Q. What can be done to salvage a job if color film is accidentally processed as black and white?

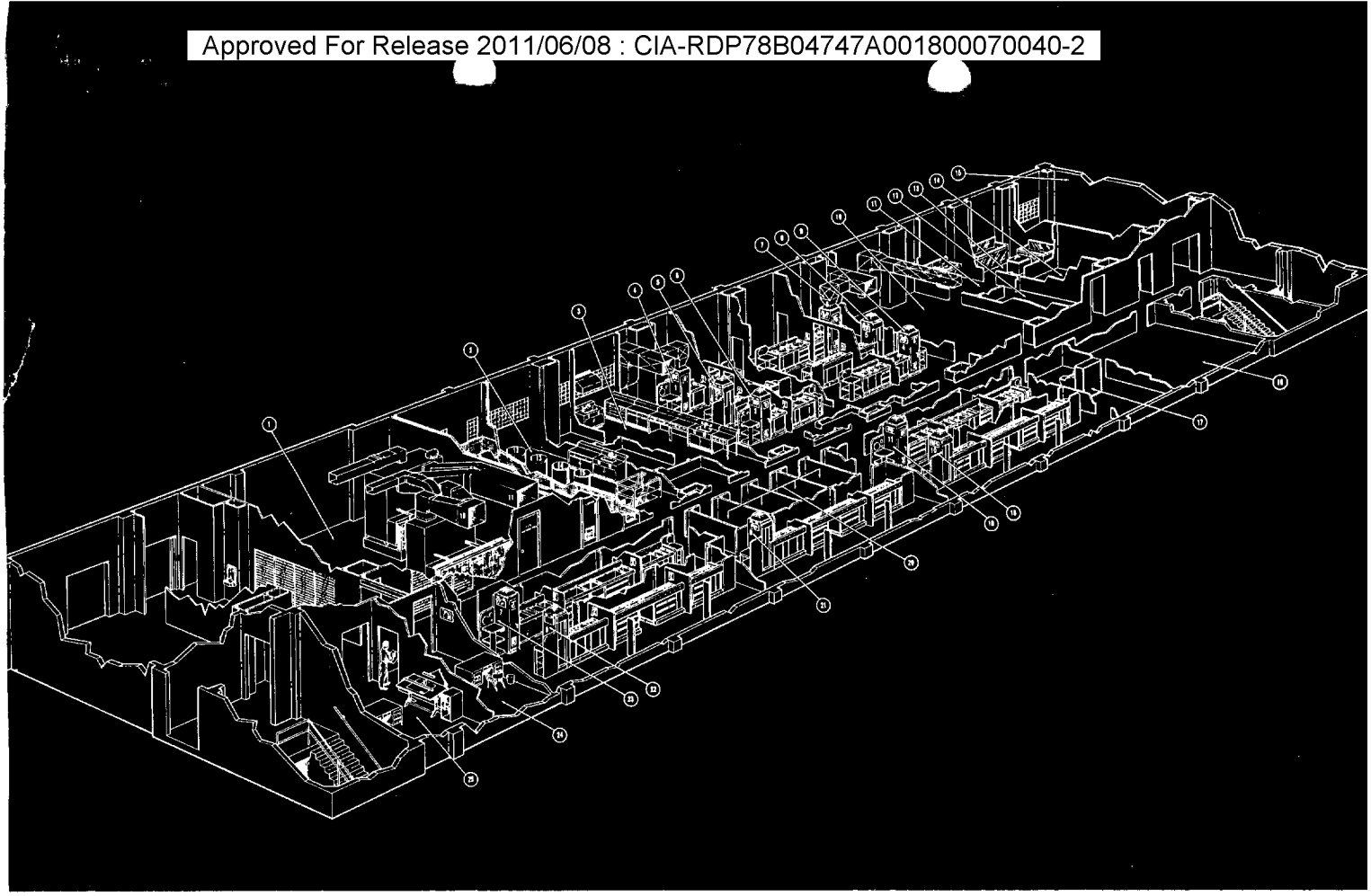
Livingood states that he knows of no way to salvage a reversal color film if processed as black and white, but in the case of color negatives he has found that the silver image can be bleached back to a silver halide and then reprocessed properly. He points out, however, that although the resultant color negative is printable it is way out in color balance.

Meisel, Morris, Smolka, Flanagan and *Stanton* gave the following succinct reply: "Nothing!"

Purrington, as well as *Stanton,* called attention to the fact that the Flexichrome Process could be used to salvage color reversal films that have been processed as black and white, although considerable hand work is involved. Eastman Kodak outlines a procedure.

Q. What about bleaching off-balance negatives? Can they be corrected?

The majority reply to this question seems to be that the use of color correction filters in printing negatives is a more sensible solution. In addition, *Meisel* notes that bleaching can be used for off-color positives. The bleaches recommended are those from both Eastman and Ansco. *Flanagan* warns that the use of bleaches has to be watched carefully. Slight bleaching can be effective in making minor corrections but excessive bleaching can lead to disaster. □



FIRST FLOOR LAYOUT of motion picture processing laboratory, Patrick Air Force Base. 1) Micron air filters and air handling units. 2) Chemical mix room. 3) Chemical analysis room. 4 & 5) 16-35 mm b&w hi-contrast negative machines. 6) 16-35 mm b&w low contrast negative machines. 7 & 8) 35-70 mm b&w hi-contrast negative machines. 9) 16-35 mm b&w positive machines. 10) Wide film room. 11 & 13) Wide film dark rooms. 12, 14, 24, & 25) Offices. 15) Chemical storage room. 16) Locker room. 17) Chemical control console. 18) 16-35 mm color negative machine. 19) 16-35 mm color positive machine. 20) Makeup dark rooms. 21) 35-70 mm rev. machine. 22) 16-35 mm color rev. machine. 23) 35-70 mm color rev. machine.

compared with four in former facilities, enable the processing of film much more rapidly than in the past. In addition, the new plant provides complete control over contamination by an elaborate air and water decontamination system.

"This is one of the first military labs built in an operational area designed to process film to commercially acceptable standards," notes W. F. Bischof, Radio Corporation of America production processing manager and installation project representative. "This was a complex job because of the air and dirt problems that exist here," he added. RCA functions as a sub-contractor to Pan American World Airways, which is responsible for the operation of the various stations of the missile test range, including the launching site at Cape Canaveral.

To clean the water used in processing, all solid material particles larger than two microns — a pencil dot is about the same size as 50 microns — are filtered by diatomaceous earth filters. Mechanical filters in two separate airconditioning systems remove all airborne particles larger than five microns.

E. B. Brady, RCA engineer who coordinated the building alterations and machine installation with the close cooperation of Major R. L. Jarman, USAF, AFMTC installation project officer, lists some facts and figures to give an idea of the complexity of the machinery.

"Five miles of chemical piping, 800 valves and 150 pumps transport more than 10,000 gallons of varied solutions from the basement to the processing machines on the first floor," Brady said. "At the same time, used chemicals from the machines are drained to the tanks below for filtering and replenishment. Each pipe bears a color-coded marker with directional arrows showing flow, source and discharge tanks."

Thermostatic controls hold the large volume of solutions within a quarter of a degree of 70 degrees F., well within the tolerances allowable in processing motion picture film. The chilled water machinery that cools the basement recirculating tanks could make 40 tons of ice daily.

One of the several unusual features in the machinery is the impingement-type dryer, which blows a high-velocity jet of hot air on the film at the rate of 3,000 cubic feet per minute as the wet film leaves the final wash stage. This dries the film so rapidly that it is ready for use in less than one minute after leaving the wash.

continued on page 68

Kodak
INDUSTRIAL
ROUND-UP

How to make your own super black-and-white developer

Plus some notes on how to enhance picture quality during and after development

There's magic in this formula. We'll gladly share its secret with you.

But first, a word of caution.

No developer, no matter how good, will work at its best with *any and all* film emulsions. We know this by experience. We've obtained our experience by researching and making developers and emulsions under one roof for a long time.

Emulsion-makers and chemists get together to fit emulsion and chemicals together. Stringent tests prove when the fit is perfect.

Made together, tested together, such materials and chemicals should work best together, used as recommended.

We know of no better way.

Now to the developer:

Be sure all ingredients are fresh, active, completely pure. We always test them to be sure. Also, be sure you don't contaminate them while weighing or holding in storage. These are routine requirements to us, ever so important to you.

Buy the best developing agent you can find. You will be using only a little of it. Carefully store the rest.

We're recommending *two*—Elon and Hydroquinone. Each does a slightly different job. Together, they complement each other to do the total job faster, developing full emulsion speed, maximum shadow detail, normal contrast, when used with proper film emulsions.

Use 2.0 grams of Elon, 5.0 grams of Hydroquinone.

IMPORTANT: Measure these and all your ingredients precisely, as we do, in a carefully controlled atmosphere. We find it's best for quality's sake to do all measuring in a year-round air-conditioned room which has undeviating humidity control. Also, take extreme care not to make mistakes. We use quality control inspectors to prevent mistakes.

Add an "accelerator." The magical ingredient that speeds up the developing process; lets you get out of the darkroom more quickly. Accelerators consist of such simple chemicals as caustic soda, sodium carbonate, ammonia, borax, and others. All are common, proven in use for a long time.

Use 2.0 grams of granular borax as your accelerator.

Now, to prevent your developer from becoming weak too quickly, add a "preservative." One of the more common preservatives is sodium sulphite, desiccated. Use 100.0 grams. NOTE: Be sure of purity, and exact quantities.

Dissolve ingredients in exactly 750 cc of water, heated to a constant 125F. Add water to make a liter.

And that's it! A developer for accomplishing sheer wizardry with films like Kodak Professional Plus-X Pan, Panatomic-X, Tri-X Pan, and others.

It's been tested to work together in a perfect fit with those films.

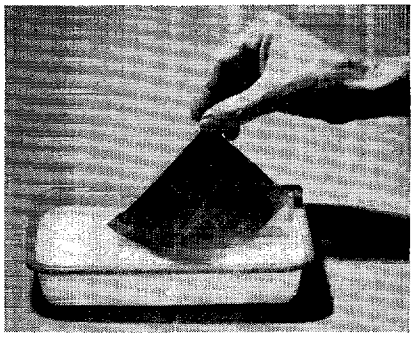
This developer (diluted 1:1) will keep Plus-X grain as fine as advertised. It will let you take full advantage of that film's 200 working index, without shifting contrast. You'll see fine shadow detail, sparkling highlights, delightful middle tones.

Truly, this is a remarkable developer. A real "discovery." As remarkable, in fact, as new Plus-X Film itself.

But why go to all the trouble of doing it yourself?

You couldn't possibly obtain the precision, the quality control, the atmospheric conditions of manufacture, all of which are easy for us. Besides, it will be less costly to you, less time-consuming, if you let us make it for you.

The fact is, we've been making and selling this remarkable developer for a long time. Many professionals are again "discovering" it because results are beautiful with Plus-X Film.



This developer is none other than good old *Kodak D-76*. Sells for 90 cents a gallon, processes 30 rolls per gallon unreplenished.

But note: This time we've recommended D-76 *diluted*. With Plus-X, dilute 1:1 (process approximately 8 minutes at 68F).

You'll see razor-edge sharpness and a fineness of grain, almost as fine as with Kodak Microdol. (Microdol, of course, requires longer development.)

A do-a-lot developer that works best with sheet films

Sheet films—professional. They go hand in hand. But, just as there are different kinds of professionals who take different kinds of pictures, so should there be a developer versatile enough to work together with sheet films, regardless of differences in photographer or subject.

DK-50 is that developer.

Professionals, who like to see nicely graduated negatives because they're the most salable kind, use DK-50, 1:1.

The result is a kind of contrast control, so to speak, where the photographer uses time to his advantage and produces a negative with good gradation through tonal range.

Some photographers, interested in development speed, get what they want to see in a negative by using DK-50 undiluted.

TOMORROW'S LAB

continued from page 33

Another time and moneysaving step is the rejuvenation of color film bleach — one of the most expensive processing solutions. Normally this bleach is used and dumped. At Canaveral it is rejuvenated and used indefinitely.

The machinery — designed, built and installed by the Houston Fearless Corporation — can be altered to permit change-overs to other processing systems, should they be required. In many instances, duplication of material has been avoided by using one common solution in several machines.

G. M. Powers, manager, RCA photographic laboratory, emphasizes that performance, not size, is the significant feature of the new installation.

He sums up the purpose of the machinery in these words: "Of course the new processing machinery increases our efficiency per man-hour expended, which is highly desirable. Even more important, however, is that we will now be able to give more dependable and somewhat faster service to civilian contractors and military agencies testing missiles on the Atlantic Missile Range." □

ELECTRONIC FLASH

continued from page 60

phy, our exposure depends on the total light. Therefore, we add the element of time and get such terms as *Beam Candle Power Seconds* (BCPS). This is the term we use for rating electronic flash units. This gives the strength of the light on the beam of the reflector. For instance, 2000 BCPS is the strength of the light on the beam and is equal to a light source of 2000 candle power acting for one second. For those so inclined, it

with a liberal arts education beforehand. Unfortunately most straight photography courses today fit young people for photojournalism or advertising photography rather than my field." He also advocates that a photographer anxious to enter industry be in business for himself sometime during his career.

Kinstler's background is an example of what he is talking about. He became interested in photography at the age of 15 and free-lanced for local newspapers. Later this led to a summer job as relief cameraman for the local daily newspaper. In 1938 he was partner in a commercial photography studio and from there joined Wright Aeronautical Corporation as junior metallurgist.

During World War II he headed a staff of five men in an experimental photo lab who were given the assignment of recording progress in the development of underwater detection devices. After the war he received a BA at the University of Cincinnati.

Not content to put in eight hours a day supervising photographers, his spare time is taken up with such activities as writing a scholarly thesis titled "The Role of Functional Photography in Industrial Communications" and presenting papers on technical photographic applications to professional groups. An energetic speaker, he is much in demand around the country and has spoken before hundreds of photographic organizations. He was on the staff of the Industrial Photography Management Seminar at the Winona School.

Only a sense of humor and affable personality keep Kinstler on an even keel during his peregrinations around the country and the carrying out of his numerous activities. He is married, with three sons, and lives in Cincinnati. Richard C. Kinstler is one of the growing breed of men on whose shoulders rest the responsibility for running photo installations in multi-million dollar companies. □

A Silver-Recovery Apparatus for Operation at High Current Densities

NICHOLAS J. CEDRONE

REPRINTED FROM JOURNAL OF THE
SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS
Vol. 67, No. 3. pp. 172–174, March 1958

HI-SPEED EQUIPMENT, INC.
73 Pond St., Waltham 54, Mass.

A Silver-Recovery Apparatus for Operation at High Current Densities

By NICHOLAS J. CEDRONE

Silver recovery systems operating at the higher current densities require thorough solution agitation at the cathode surface in order to deposit metallic silver continuously. In the apparatus described, agitation is provided by an external pump. With the solution nozzles located tangential to a cylindrical cathode, high surface velocity is attained and mass flow held to reasonable values. Thus, the problem of excessive mechanical energy input is avoided, while the scrubbing velocity provided permits current densities as high as 10 amp/sq ft.

Electrolytic silver-recovery systems may be separated generally into two classes: those which operate at low current density with no solution agitation, and those which operate at high-current densities with vigorous solution agitation.

Low current density systems operate at 50 ma to 400 ma/sq ft of cathode,[1] but the higher currents are generally avoided. Since the permissible plating rate is affected by a variety of conditions, such as bath composition, silver concentration and gelatin concentration among others, and since these factors may vary considerably, nonagitated systems are usually operated at current densities of 50 ma to 100 ma, a range which is satisfactory for nearly all conditions. The systems are operated without careful control or supervision, and are best suited for processing rates which yield 2 to 3 oz of silver per day.

If we take a typical system operating with a sodium acid hypo bath, current density would be approximately 0.1 amp/sq ft of cathode. Assuming a typical current efficiency of 90%, a cell would require 100 sq ft of cathode surface in order to accommodate a film-processing rate of 1000 ft of 35mm film per hour. This indicates that low current density systems could not be employed in most motion-picture laboratories on the basis of space requirements alone.

In order to obtain recovery rates which are of practical interest to motion-picture laboratories and other film laboratories where the film-processing rate yields 20 oz or more of silver per day (equivalent to 20,000 ft of 35mm film), it is necessary to turn to the other class of electrolytic systems, those which are vigorously agitated and operate at higher current densities.

The chemistry of hypo baths during electrolysis is very complex and has been thoroughly presented elsewhere.[1,2] For our purposes, it is sufficient to note that the typical sodium hypo or ammonium hypo bath found in continuous processing machines is subject to electrolysis at practical rates by merely providing the proper physical conditions of vigorous agitation and continuous filtration.[2] A typical sodium acid hypo, which will tolerate 200 ma/sq ft without sulfiding under static conditions, will tolerate on the order of 10 times this current when agitated to provide a velocity of 1 ft/sec relative to the cathode.

Because of the high current densities which agitated systems will tolerate, it is possible to use them effectively in hypo systems containing several hundred gallons and which fix as much as a million or more feet of film per day. These recovery systems are more efficient in terms of weight of silver recovered as a percentage of total silver available and in terms of reduction of hypo costs.

Recovery Systems

Recovery systems operating at the higher current densities will tolerate current according to the silver concentration of the solution and the rate of solution agitation. Figure 1 shows the relationship between current density and the silver content, with the solution velocity held constant at 1 ft/sec.[1] Figure 2 shows the relationship between current density and agitation, with silver content held constant at 2.2 g/l.[3] In order for recovery to proceed at current densities in excess of 1 amp/sq ft, continuous filtration is also necessary to remove traces of sulfide which form intermittently at the cathode surface and would ultimately accumulate to an extent which would reduce the effective plating area or would eventually "poison" the entire plate.

The various arrangements for providing agitation have been listed by Hickman[2] as follows:

(1) air or gas bubbled between the electrodes;

(2A) rotating cathode, stationary anode; or

(2B) rotating anode, stationary cathode;

Presented on May 1, 1957, at the Society's Convention at Washington, D.C., by Nicholas J. Cedrone. Hi-Speed Equipment, Inc., 73 Pond St., Waltham 54, Mass.
(This paper was received on August 5, 1957.)

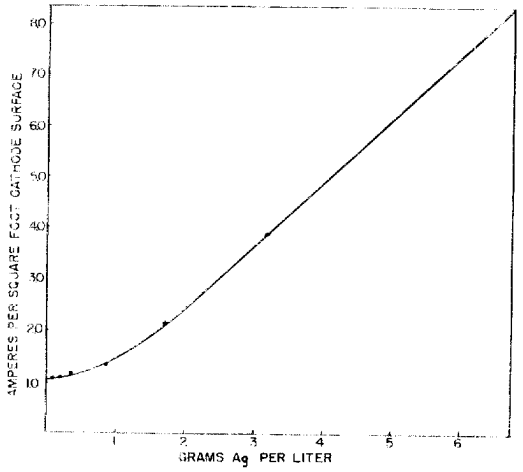


Fig. 1. Relationship between permissible current density and silver concentration.

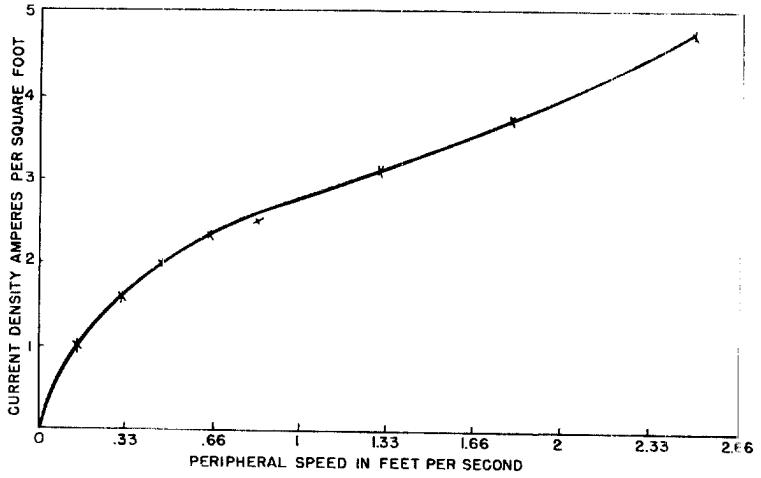


Fig. 2. Relationship between permissible current density and surface velocity at the cathode.

(3) paddles moving between anode and cathode;

(4) external pump stirring; and

(5) external paddle stirring.

At least one design based on each of the foregoing methods has been constructed and used. A recovery cell employing air turbulation was the first successful cell used in a motion-picture laboratory and was designed by Garbutt & Associates.[4] This design comprises a rectangular tank with alternate carbon and monel plates reaching across the narrow dimension and hanging down in the fluid. Air tubes are positioned between the plates at the lower extremities and release air blasts to provide the required agitation. Hickman points out three shortcomings of the air-agitated system.[2] The cathode is depolarized; the bubbles occupy space, reducing the effective plate area; and the foam produced tends to wet the electrode hangers.

An example of the rotating cathode design is set forth in a patent by Leverenz.[5] Essentially, this comprises a tub which may be the cathode, or a tub containing one or more concentric cylinders which form the cathode. A beam lies across the top of the tub and mounts a motor driving carbon anodes which are suspended in proximity to the cathode cylinders by a spider structure. Agitation at the surface of the cathode (both inside and outside each cathode cylinder) is provided by the action of the carbon anode sweeping past.

An example of the rotating anode method is shown by a device described by Duisenberg.[6] This consists essentially of a series of stainless-steel disks threaded onto a shaft with spacers to keep the disks separated by approximately $\frac{1}{2}$-in. Two slabs of carbon with the long dimension parallel to the shaft complete the array and the entire assembly is suspended in a hypo tank. In the design described, rotation of the shaft at a speed of 179 rpm provides the required agitation for an average maximum current density of 2.5 amp/sq ft. Systems of this type generally provide excellent plating but require disassembling in order to remove the silver.

The design which uses paddles moving between anode and cathode is probably the most familiar of all. Systems of this design are widely used by the larger motion-picture laboratories and were supplied by Eastman Kodak Co. as Model 1 and Model 2. The Model 1B (known as Hickman Cell) consists of a rectangular tank approximately 24 by 50 by 28 in. fitted with alternate carbon and stainless-steel plates, spaced about 2 in. apart, which reach across the narrow dimension of the tank and are suspended into the solution. The plates are slotted to permit straddling a shaft which carries sets of paddles arranged to occupy the space between the alternate plates. In the particular system described by Hickman,[2] the shaft carrying the paddles is rotated at about 80 rpm which permits a total current of about 200 amp on a total surface of 90 sq ft for an average current density of approximately 2.2 amp/sq ft.

By reducing the size of the cathode and making the cathode from a series of rods rather than a flat sheet, higher currents can be tolerated because of the more turbulent agitation resulting from the discontinuous surfaces. In one design, alternate rows of carbon-rod anodes and stainless-steel cathodes are used and agitation is provided by a standard or conventional propeller mixer mounted over the side at one end of the tank and positioned so as to direct flow in a path around the inside of the tank.[2]

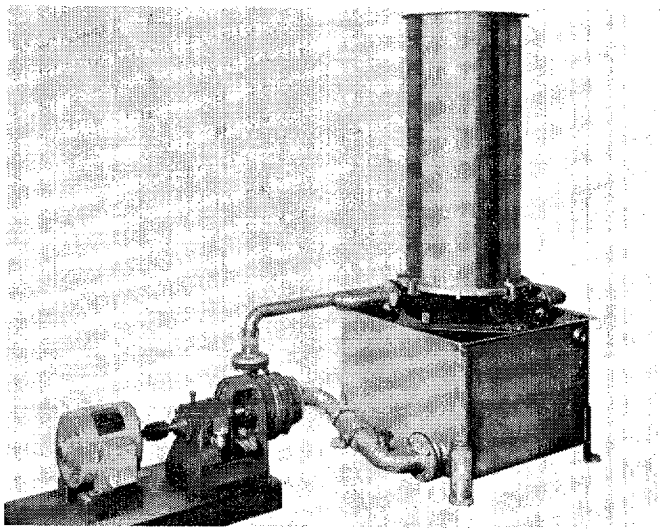


Fig. 3. "Silver Tower" assembly complete with recirculation pump and sump tank.

External Pump Agitation

The principle of increased turbulence resulting from discontinuous cathodes was used in a design by Doran to obtain effective agitation by an external pump.[7] In this design, a rectangular tank is fitted with alternate rows of anode rods and cathode rods which are suspended from beams reaching across the top. The solution is withdrawn from one end of the tank and pumped back in at the other end. Since the tank cross section is so large compared to pipe-line area, average solution velocity through the tank is low but the discontinuities provided by rods create sufficient turbulence to allow plating at rates suitable for motion-picture laboratories.

Another application of external pump agitation is one discussed by Hickman[2] in which solution is recirculated by a centrifugal pump and discharged through nozzles placed between the plates. This arrangement was not considered successful because of high pump-power requirements and inferior plating relative to other systems.

A more recent example of external pump agitation is seen in the Model S-5 Silver Tower manufactured by Hi-Speed Equipment, Inc. The Tower comprises a cylindrical cathode and anode mounted concentrically on an insulated base plate (Fig. 3).* The Tower assembly is approximately 43 in. high and is mounted across the top of a sump tank which is approximately a 27-in. cube.

Hypo from the sump tank is pumped to the Tower through two nozzles which are tangentially located at the Tower base. These nozzles discharge into the annular space between the anode and the cathode and the solution is directed into a circular flow by the cathode. Because of the high kinetic energy of the fluid stream as it leaves the nozzles, the fluid continues to swirl and climbs in an ascending helix. This motion is represented by the arrows in the diagram (Fig. 4). Vanes located at the top of the anode deflect the fluid at four points and cause it to cascade toward the center of the Tower where it falls into a filter sock suspended concentrically within the anode. The fluid runs downward into the sump and is again recirculated by the centrifugal pump.

Velocity at the nozzle is calculated as 39.7 ft/sec. At the point just above the lower end of the cathode, the velocity in a horizontal plane is 9.8 ft/sec. At a point just below the top surface of the fluid, the velocity in a horizontal plane is 3.5 ft/sec. These velocities are obtained with a mass flow of 82 gal/min.

The combination of horizontal inlets and cylindrical cathode provides high surface velocity with relatively low mass flow.

By way of contrast, if the anode and the cathode were both unwrapped and made into flat sheets while maintaining the same area, the same height, and the same space between the two, we would find that a mass flow of 1000 gal/min would be necessary to provide an average velocity of 3.5 ft/sec over the cathode sur-

* Patent pending.

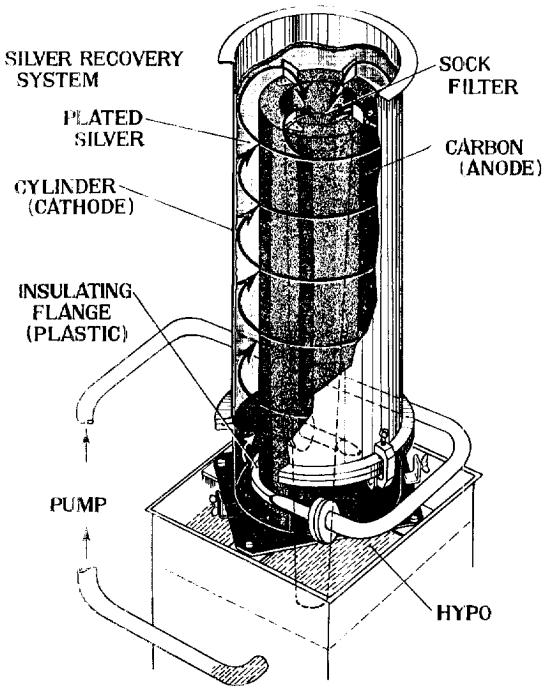


Fig. 4. Cutaway view of the Hi-Speed "Silver Tower."

face. The technique of circular flow is, then, clearly an effective means of reducing the pump horsepower without narrowing the anode-to-cathode space to the point of inviting treeing and short circuiting.

In operation, silver is plated continuously on the inside of the cathode and the solution is filtered continuously as it cascades through the center of the anode back to the sump tank.

Because the surface velocity in the Tower is considerably higher than in most "high-turbulation" systems, the normal current densities are also correspondingly higher. After an initial cover of bright plate is formed on the wetted surface of the cathode, the current is gradually increased as allowed by the silver concentration in the hypo. Current densities of 10 amp/sq ft have been maintained with acid hypo containing slightly more than 2 g of silver per liter. Ordinarily, the current is held to approximately 70 amp for a current density of 5.8 amp. This is in keeping with the widespread practice of providing an extra margin of safety in the operation of silver recovery systems so as not to endanger the hypo. At 70 amp and 75% current efficiency, approximately 6.8 troy oz of high-purity silver would plate on the cathode each hour.

The lowest velocity in the Tower occurs near the top of the cathode in the region above the anode. This area is, therefore, most susceptible to sulfiding and offers a convenient point for checking plate color and texture. Plating in the less visible region lower in the annular space will generally be as good or better than at the top, since surface velocity is higher towards the bottom.

When operating close to maximum recovery rates, the Hi-Speed Tower produces silver with a surface texture approximately that of fine sandpaper and with a tan color. The color was at first assumed to indicate imminent sulfiding. However, the color was not locked in with the plate but rather was in the form of a surface haze which required only gentle scraping to reveal bright silver directly underneath. This color was attributed to the oxidation products of carry-over developer as reported by Sharpe,[8] particularly since silver plate of this appearance was analyzed as over 99% pure silver.

After the silver plate has accumulated to a thickness of $\frac{1}{8}$ in. or more, the cathode is lifted from the Tower and the silver is removed. The bond between silver and stainless steel is normally a poor one. However, in the present case we have a cylinder of silver encircled by a cylinder of stainless steel. The silver is locked in place by what is termed "arch action" with each bit of silver acting as the keystone for its neighbors. This effect is an advantage while the cell is in operation because it prevents chunks of silver from falling away and possibly shorting the cell. To remove the silver, it is only necessary to chip out a narrow strip with a mallet or spatula and thus effectively remove the "lock" holding the silver. Large sheets of silver can then be peeled inward without difficulty.

This equipment is the result of an attempt to design a silver-recovery system which would require a minimum maintenance, yet permit high recovery rates. The first models fell short of the goal and were susceptible to shorting. An improved design followed in which the anode-to-cathode space was increased to 2 in. and the method of insulating the base was changed from rubber to PVC (polyvinyl chloride). With the shorting difficulty eliminated, the pump appeared to be the only remaining source of possible difficulty and a sturdy, conservatively rated unit was selected.

Units of the current design have been in operation for over one year without any breakdown or maintenance problems reported.

Acknowledgment

The author wishes to thank H. E. White of Eastman Kodak Co. for information and comments pertinent to the design.

References and Bibliography

1. A. A. Rasch and J. I. Crabtree, "Electrolytic recovery of silver from fixing baths at low current density," *Phot. Sci. Tech. Serie II, 2:* 15–33, 1955.
2. K. Hickman, W. Wyerts and O. E. Goehler, "Electrolysis of silver-bearing thiosulfate solution," *Ind. Eng. Chem., 25:* 202–212, Feb. 1933.
3. K. C. D. Hickman, et al., "Method for the recovery of silver from used photographic fixing solutions by electrolysis," U.S. Pat. 1,954,316, Apr. 10, 1934.
4. F. E. Garbutt and T. M. Ingman, "Method and apparatus for recovering silver from fixing solution," U.S. Pat. 1,866,701, Mar. 13, 1929.
5. Wilhelm Leverenz, "Process and equipment for electrolytic regeneration of exhausted photographical fixative baths," Canadian Pat. 491,453, Mar. 24, 1953.
6. Charles E. Duisenberg, "Silver recovery and prolongation of fixing baths," Jour. *SMPTE, 65:* 429–431, Aug. 1956
7. A. B. Doran, "Method and apparatus for the recovery of metal from a liquid," U.S. Pat. 2,158,410, June 1935.
8. C. J. Sharpe, "The formation of colored solutions during electrolysis of used fixing baths," *Brit. J. Phot., 101:* 140, 1954.
9. K. C. D. Hickman, "Method for photographic processing," U.S. Pat 1,905,067, Apr. 25, 1933.
10. K. Hickman, C. Sanford and W. Wyerts, "The electrolytic regeneration of fixing baths," *Jour. SMPTE, 17:* 568–590, Oct. 1931.